Marsh Creek Water Quality Project Update

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Photo by Carolynn Firth

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Technical Report AM-MC09
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Idaho Association of
Soil Conservation Districts

Introduction

Marsh Creek originates in the Albion Mountains south of Albion, Idaho. The basin drains approximately 75,800 acres. Primary activities within the basin include: farming, livestock grazing, wildlife enhancement activities, town sites, and recreation. A majority of this basin is held in private ownership (55%), with most of the private land being found in the middle and lower portions of the watershed. The upper watershed is made up of BLM (25%), USFS (17%) and State of Idaho (3%) lands.

Marsh Creek is on the state of Idaho's 303(d) list; however, pollutants of concern are currently listed as 'unknown'. The Idaho Department of Environmental Quality (IDEQ) is presently reviewing Marsh Creek, and a total maximum daily load (TMDL) document is expected for the subbasin within the next two years. Past monitoring conducted by the Idaho State Department of Agriculture (ISDA) suggested that phosphorous and temperature were likely areas of concern to water quality in the area Campbell (1999).

Monitoring Request

In 2007, the IDEQ and the Idaho Soil Conservation Commission (ISCC) expressed interest to the Idaho Association of Soil Conservation Districts (IASCD) regarding the collection of water quality information in the Marsh Creek watershed. With the assistance of IDEQ and the ISCC, eight sites were selected to provide an overview of water quality within the basin.

IASCD worked with the East and West Cassia Soil Conservation Districts, the Mid-

Snake Watershed Advisory Group (WAG), Idaho State Department of Agriculture (ISDA), IDEQ, ISCC, and private landowners to meet the following objectives:

- Assess existing water quality conditions within the Marsh Creek subbasin.
- Determine sediment, total phosphorous, and bacteria impairment in the watershed to assist with the creation of the Marsh Creek TMDL.
- Conduct riparian and bank stability assessments to determine existing conditions and areas of concern.
- Evaluate BMP effectiveness.
- Use the data for public awareness.

Monitoring Program

Water quality monitoring began in April 2007 and continued through October 2008. All sites were monitored bi-weekly March through November and monthly December through February. Eight initial sites were examined for sediment, total phosphorous (TP), dissolved phosphorous (OP), Escherichia Coli (*E-coli*), nitrates, bacteria, pH, conductivity, dissolved oxygen (DO), and temperature (Table 1; Figure 1).

Two additional sites were subsequently added to the original study. The first site, one-half a mile above MC1 (MC1b), was added to identify groundwater nitrate contributions to lower Marsh Creek. Also, an additional site (Ponds) was added below the settling ponds constructed near MC3 to quantify the ponds' effectiveness in trapping sediment.

Table 1. Monitoring site descriptions.

Site	Location
MC1	1 mile above confluence with Snake River
MC1b	1.5 miles above confluence of the Snake R.
MC2	1.5 miles below the 6 S Ranch
Ponds	At the outlet of the two ponds on 6 S Ranch
MC3	100 meters above 6 S Ranch settling ponds
MC4	At Marsh Creek Road crossing approx. 2 miles below Marsh Cr-Land Cr confluence
MC5	400 meters above 6 S Ranch gate above Albion
HC	50 meters below 800 S road crossing (approx. 1.5 miles above Marsh Cr confluence)
LC1	¼ mile above confluence with Marsh Creek
LC2	200 meters above 6 S Ranch gate above Albion

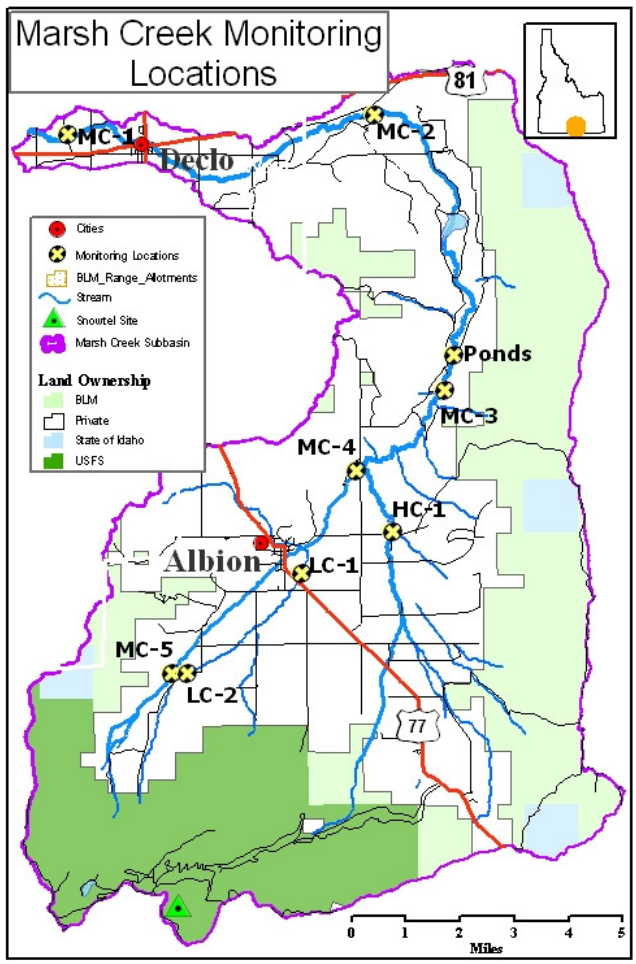

Figure 1. Monitoring site locations.

Sampling Methods

Water quality samples were collected by grab sampling directly from the source. Sampling sites were located away from obstructions to avoid backwater effects within the channel. For shallow creeks, six one liter grab samples were collected from a well-mixed section, near midstream at approximately mid depth. For larger creeks, multiple grab samples were collected at equal intervals across the cross section and vertically integrated using a DH-81 sampler to provide a representative sample.

Except for bacteriological samples, grab samples for each site were composited into a 2.5-gallon polyethylene churn sample splitter. The composite sample was then thoroughly homogenized and poured off into properly prepared sample containers. For samples requiring filtration (orthophosphate), a portion of sample was transferred into a vacuum unit and pressure-filtered through a 0.45 µm filter. The resultant filtrate was transferred directly into a properly prepared sample bottle.

Nutrient samples that required preservation were transferred into 200 mL sample containers containing sulfuric acid (pH <2). The polyethylene churn splitter was always thoroughly rinsed with source water at each location prior to sample collection. Bacteriological samples were collected directly from midstream into properly prepared sterile sample bottles. Parameters, analytical methods, preservation and holding times are included below in Table 2.

All sample containers were marked to indicate station location, sample identification, date, and time of collection. All sample containers were placed on ice in a cooler until delivery to Analytical Laboratories in Boise, Idaho for analysis.

Table 2. Holding times and methodologies.

Parameter	Sample Size	Preservation	Holding Time	Method
Suspended Sediment Concentration	1 L	Cool 4°C	7 days	EPA 160.2
Total Phosphorous	200 mL	Cool 4°C, H_2SO_4	28 days	EPA 365.4
Ortho Phosphate	100 mL	Filtered, Cool 4°C	24 hours	EPA 365.1
Escherichia Coli	200 mL	Cool 4°C	30 hours	EPA 1105E
Nitrate	200 mL	Cool 4°C, H_2SO_4	28 days	EPA 352.3

Field Measurements

Field measurements for temperature, dissolved oxygen (DO), conductivity, discharge, and a visual assessment of turbidity were performed at each site. Calibration of all field equipment was in accordance with the manufacture specifications (Table 3).

Table 3. Equipment Calibration Parameters.

Parameter	Equipment	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance and TDS	Orion Model 115	Conductance standards
pH	Corning Model 313	Standard buffer (7,10) bracketing for linearity

Stream Flow Measurements

Flow measurements were collected using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenth-depth method (60% of the total depth below water surface) was used when the depth of water was less than three feet. At each station, a transect line was set up perpendicular to flow across the width of the creek. The discharge was computed by addition of the products of the flow cross-sections and the 30-second average velocities for each of those sections. Results are expressed in cubic feet/second.

Quality Assurance and Quality Control (QA/QC)

Analytical Labs uses EPA approved and validated methods. Laboratory QA/QC results generated from this project can be provided upon request. QA/QC procedures from the field-sampling portion of this project consisted of duplicates and blanks (at least 10% of the sample load). The field blanks consist of laboratory grade deionized water transported to the field and poured off into prepared sample containers. The blank sample was used to determine the integrity of the field team's handling of samples, the condition of the sample containers supplied by the laboratory, and the accuracy of the laboratory's methods. Duplicates consist of two sets of sample containers filled with the same composite water from the same sampling site.

Results

Five water quality parameters are detailed in this report: discharge, sediment concentration, nutrient concentration (total phosphorous and nitrates), temperature, and bacteria.

Water quality tends to be very poor in Marsh Creek and its tributaries early in the year when discharge is high. As the flows drop to base flow conditions, water quality generally stabilizes and improves significantly.

With the exception of nitrate, all parameters indicated good water quality from MC-2 to the Snake River. The poorest area of water quality was the middle section of the study area between Albion and the Six S Ranch reservoir (i.e. MC3, MC4, HC, and LC1). These sites showed relatively elevated sediment and phosphorous concentrations in the spring during high discharge, and elevated bacteria concentrations during all but the coldest months compared to other sites within the watershed. High bacteria concentrations, however, are present throughout nearly the entire basin.

Discharge

Water in Marsh Creek and Land Creek originates from both snowmelt and springs located high in the watershed. Surface flow fed by snow melt generally dominates the system through late May. After the majority of the snow has disappeared, groundwater discharges from springs support the system through the remainder of the year. Surface flow processes dominate Howell Canyon Creek the better part of the year.

The highest recorded Marsh Creek discharge was 38.9 cfs at MC-3 on March 26, 2007 (Figure 2); however, because monitoring was performed every other week through the spring and summer, these peaks are probably somewhat conservative. The high springtime flows in Marsh Creek diminished to base flow levels by mid-May. In 2008, an unusually cool spring delayed peak runoff in Marsh Creek until early June.

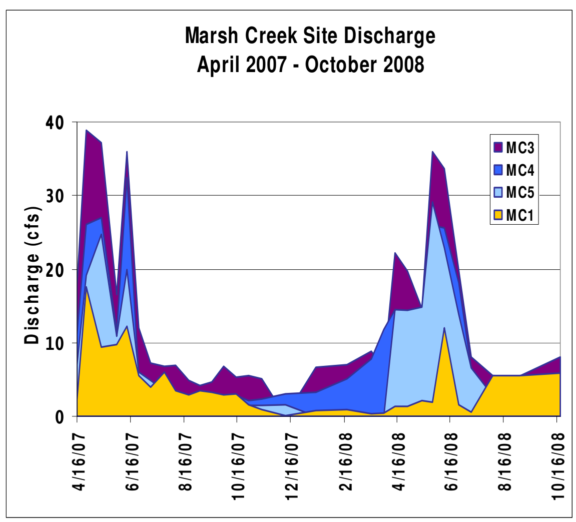

Figure 2. Discharge for all sites.

Measurable discharge was witnessed year round at all sites except MC2. This site, located below the 6 S Ranch, went dry both years around the middle of June largely due to agricultural diversions and reservoir storage in the middle part of the watershed. However, because of inputs from canal tail water and springs located along Marsh Creek, water flowed year round at MC1.

Average yearly flows in Marsh Creek ranged from 2.1 cfs at MC2 to 13.5 cfs at MC3 (Figure 3). Average flow in the two tributaries monitored over the study period, Howell Canyon Creek and lower Land Creek, were 1.6 cfs (HC) and 4.3 cfs (LC1).

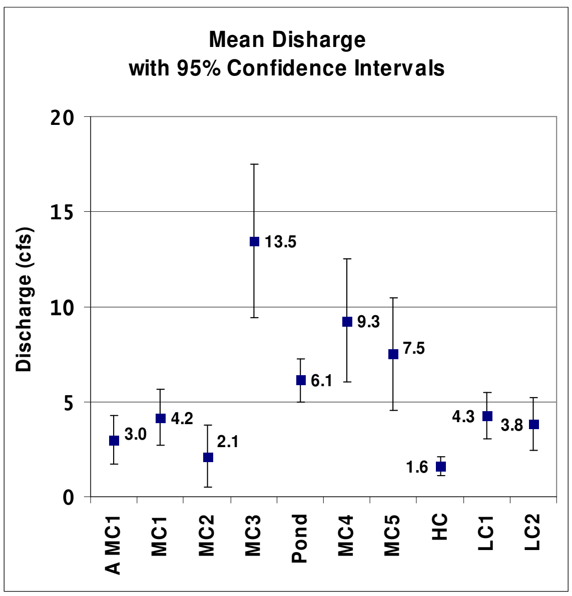

Figure 3. Mean yearly discharge (all sites).

Sediment

Sediment can negatively impact aquatic life. Extended periods of elevated sediment levels can interfere with the ability of fish to feed, damage fish gills, and reduce growth rates. High levels of sediment can also lead to a decrease in available fish spawning and rearing habitat. Sediment can also be a major contributor of chemical nutrients such as phosphorous.

Sediment seems to be the primary water quality issue within the basin. The data shows that sediment concentrations increase dramatically with increases in flow. In all cases, the highest sediment concentrations were found during peak runoff periods in late April (Figure 4). The highest instantaneous sediment concentration measured was 331 mg/L at the lower Land Creek site (LC-1) on April 30th.

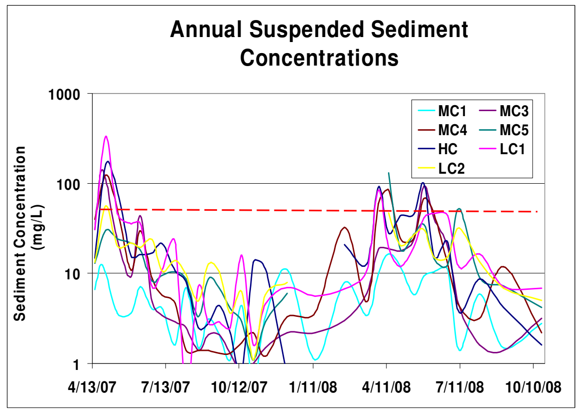

Figure 4. Instantaneous sediment concentrations. The red dashed line represents the 80 mg/L instantaneous target generally set in IDEQ TMDLs for southern Idaho.

Annual mean sediment concentrations are relatively low in the upper portion of the watershed (MC5 and LC2) and trend upward as they approach the middle portion of Marsh Creek near MC3 (Figure 5). By the time Marsh Creek enters the Snake River, the average yearly sediment concentration is 5.7 mg/L. However, this low average value can be a bit misleading because the majority of the water entering the Snake River at this point is from canal water returns and nearby groundwater springs. Although sediment concentrations appear low at this site, the stream bed is shrouded in over 2 feet of fine sediment. This sediment is likely deposited during high flow events in the springtime.

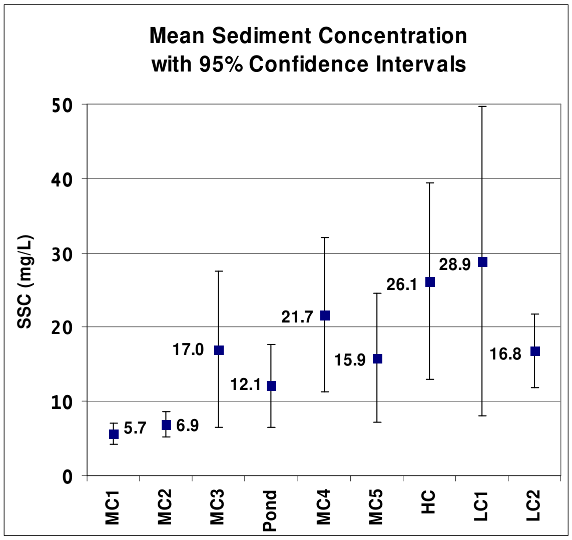

Figure 5. Mean yearly sediment concentrations (all sites).

A large portion of the sediment being transported through the middle reach of Marsh Creek appears to emanate from bank cutting-calving located just above MC4. In October 2008, IASCD and ISCC conducted a stream bank erosion inventory on the reach of Marsh Creek between MC4 and the diversion point just over one stream mile above the monitoring location. The investigation revealed numerous cut banks over five feet high and 80 feet long. Lateral movement of bends along the banks was estimated from 6 to 12 inches per year. The survey concluded that this reach contributed approximately 320 tons of sediment to the creek per year.

The two sediment basins constructed in 2006 on the Six S Ranch seem to be somewhat successful at removing sediment from the creek (Figure 6). The data shows that the ponds are effective in reducing sediment during periods of elevated concentrations— generally during the springtime when discharge is peaking.

Measured reductions of in-stream sediment concentrations confirm the removal of over 10.8 tons of sediment. However, due to large influxes of springtime sediment in this middle portion of Marsh Creek, the sediment basins were almost completely full by early July. At this point they appeared to be ineffective at removing sediment and even reduced water quality late in the season. Additionally, due to their limited size, only about 25% to 35% of the discharge passing MC3 was diverted to the basins for treatment.

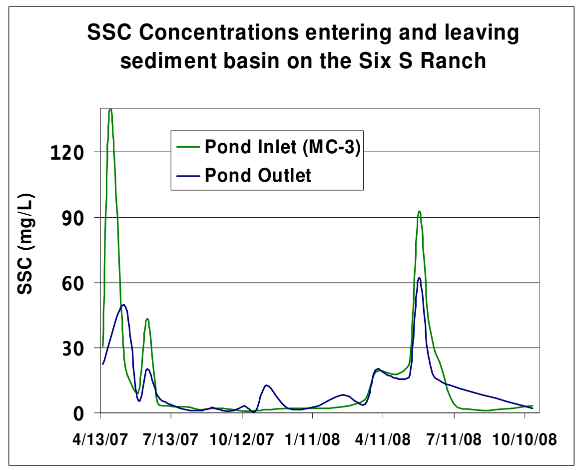

Figure 6. Sediment reduction due to the sediment ponds on the Six S Ranch.

BMPs that address stream bank revegetation and stabilization should be explored in order to reduce sediment issues in Marsh Creek and its tributaries. Measures might include cattle exclusion, off-site watering, and planting new willows in the stream riparian area.

Total Phosphorous

Total phosphorous is the measurement of all phosphorous, organic and inorganic. A portion of this phosphorus is in a dissolved form (orthophosphorous) which can be readily utilized by plants and can lead to impairment of water bodies if the concentration is high. Elevated concentrations of phosphorous can lead to increases in nuisance algae. When the algae die, decomposition requires a large amount of oxygen. Dissolved oxygen levels may then decline and this may lead to increased fish stress and/or mortality.

The highest TP values in Marsh Creek were generally found where sediment concentrations where elevated. This would suggest that the majority of TP present in the system is bound to soil particles. The highest TP concentration measured was 0.35 mg/L at the Howell Canyon Creek site (HC) on April 30th. Mean seasonal values for two of the ten sites (MC1 and MC2) were above 0.10 mg/L. Although the mean value exceeded this concentration at only two sites, instantaneous concentrations above 0.10 mg/L were seen at least once at every site in the study area (Figure 7).

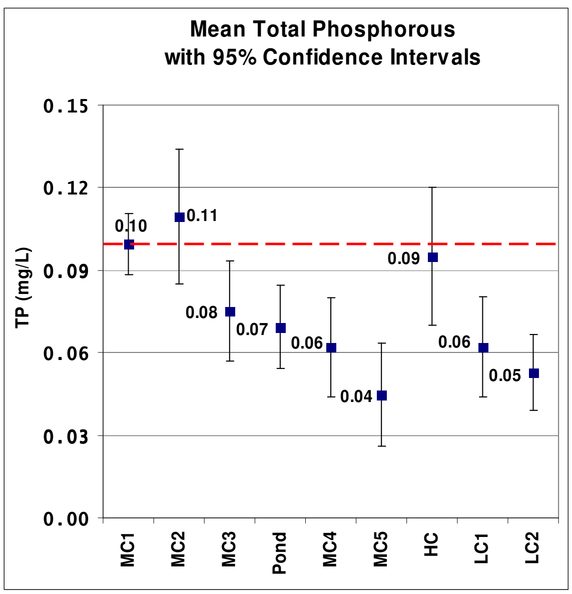

Figure 7. Total Phosphorous (TP) concentrations for all locations. The red dashed line represents the 0.10 mg/L instantaneous target generally set in southern Idaho IDEQ TMDLs.

TP concentrations below MC3 dropped a modest 0.006 mg/L due to sediment reduction attributed to the new sediment basins on the Six S Ranch.

The portion of dissolved phosphorous as a percentage of total phosphorous steadily increased moving from the top of the watershed downward (Figure 8). This is opposite of what would be expected. Generally speaking, if one moves down a watershed where sediment concentrations are increasing, the ratio of dissolved phosphorous to TP decreases because the majority of phosphorous present is bound to soil particles and is therefore unavailable to being dissolved in the water column.

In Marsh Creek, both TP and dissolved phosphorous are increasing. However, dissolved phosphorous concentrations are increasing more rapidly then TP concentrations— even with the large increases in sediment concentrations. This suggests that sources other than soil particles (i.e. cow manure and groundwater returns from agricultural fields, tail waters and canal return waters) are making major contributions to the phosphorous load in the system. The data would also suggest that the lower stream reaches within the watershed are at a much greater risk of impairment from biological factors like nuisance algae due to these elevated concentrations of dissolved phosphorous.

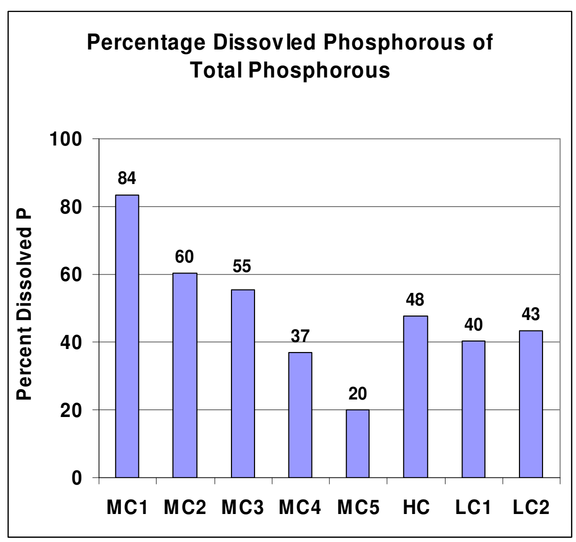

Figure 8. Percentage of dissolved phosphorous to total phosphorous (TP).

Nitrates

Like phosphorous, nitrates can also cause growth of unwanted algae and other problem aquatic plants in streams. The USEPA maximum contamination limit (MCL) for nitrate in drinking water is 10 mg/L for human consumption.

All monitoring locations were tested for nitrates early in the year. The data show that nitrates do not seem to be a problem in the upper and middle reaches of the study area. However, nitrates do seem to be of concern at the lower site, MC-1, near the Snake River. This site resides in the Cassia County Nitrate Priority Area (CCNPA). In 2008, the CCNPA was ranked as the ninth most degraded groundwater area with respect to nitrates in the State of Idaho (IDEQ).

Early data at MC1 showed elevated nitrate concentrations. However, it was unclear if the source of the nitrate was from surface water, local groundwater discharges into the stream, or both. To address this issue, an additional site at the next road crossing upstream, approximately one-half of a mile above MC1, was added.

The data from these two sites suggests that canal water entering Marsh Creek one mile above the upper site accounts for the majority of nitrate, roughly 1.9 to 4.3 mg/L, from July until early December. As surface flows from the canal begin to decrease, the relative contribution from groundwater inputs increases. This results in a reduction of dilution of concentrated nitrate groundwater inputs from surface water. Once the majority of the surface water discharge disappears during the winter months, the nitrate concentration at the lower site (MC1) quickly rises (Figure 9).

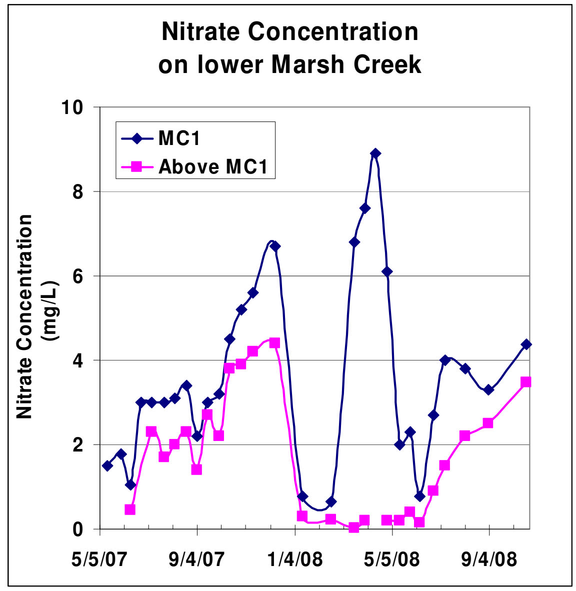

Figure 9. Nitrate concentrations at MC1 and the site located one-half mile above MC1. USEPA recommends concentrations below 10 mg/L for human consumption.

Temperature

Temperature is a major factor in determining the composition of an aquatic community. It often determines which organisms are present or absent. As temperature increases, the water's ability to hold dissolved oxygen decreases. This can lead to a stressful environment for fish.

The IDEQ has determined that the instantaneous temperature of any stream listed for cold water biota should never exceed 22 °C and average daily temperature should stay below 19 °C (IDEQ 2002). Additionally, because Marsh Creek and nearby streams are listed for salmonid spawning, a more stringent maximum instantaneous temperature criterion of 13 °C is mandated for the periods of May 1st – June 30th and September 15th – November 15th.

The highest recorded temperature observed was 21.1 °C at the Howell Canyon Creek site on July 25th. The lowest site in the

Marsh Creek watershed, MC1, was the largest temperature offender exceeding the state standard for 29% of all observations; Howell Canyon Creek (HC) violated the standard for 20% of days monitored. All of these violations occurred during the spring and fall spawning periods, when temperature standards are the most stringent.

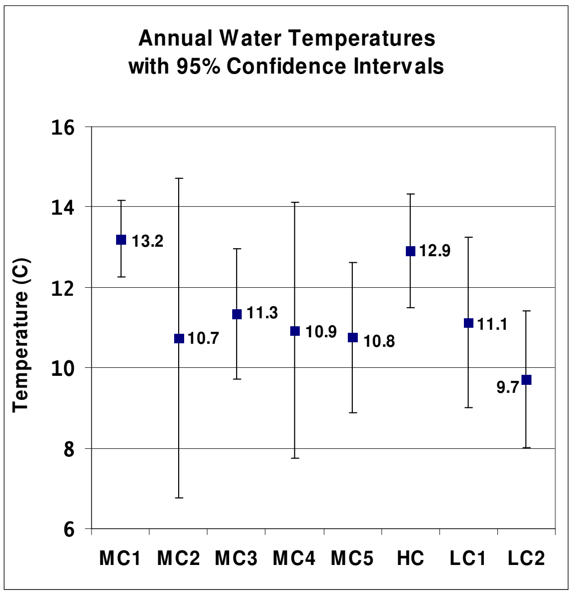

Figure 10. Observed temperatures for all monitored locations.

Mean maximum temperatures seemed a bit high for the area (Figure 10). Improving riparian shading (as proposed in the potential 319 sediment project mentioned above) could help in cooling the in-stream temperatures above MC-3.

All instantaneous temperature measurements were completed before 2:00 PM— many hours before the warmest part of the day. It is likely that the reaches of streams mentioned above exceed the state standards far more often then was initially found.

Bacteria

E-coli is a species of coliform bacteria used by the state of Idaho to indicate the presence of pathogenic organisms. When present in high concentrations, these pathogens can cause sickness or death in humans. When an *E. coli* measurement exceeds 406 colony forming units (CFUs) in a primary contact area, IDEQ requires that five samples be gathered over a 30-day period in order to determine if the water body is meeting state water quality standards (IDEQ 2002). However, since this amount of monitoring was impractical for this monitoring regime, the 406 CFUs instantaneous concentration is used for all streams except Howell Canyon Creek to illustrate the likelihood of water quality impairment. Howell Canyon Creek will use the secondary contact recreation (SCR) criterion of 576 CFUs.

Annual mean *E-coli* levels in the Marsh Creek watershed were high at all sites except MC1 and MC2 (Figure 11). The highest concentration that the test is capable of measuring, 2,400 colonies per 100 mL, was observed *at least* once at MC4, MC5, LC1, LC2, and HC. The site on Howell Canyon Creek (HC) was the most frequent offender—exceeding the SCR standard for 58% of all samples taken. Other sites of concern that exceeded the PCR standard were: MC4 (52% exceeded), LC1 (48% exceeded), LC2 (36% exceeded), and MC3 and MC5 (both 32% exceeded). Cattle have unabated access to the streams in the middle and upper portions of Land Creek and Marsh Creek (LC1, LC2 and MC5, respectively). Improperly installed and maintained septic systems along the length of the stream may also be adding to the high bacteria levels.

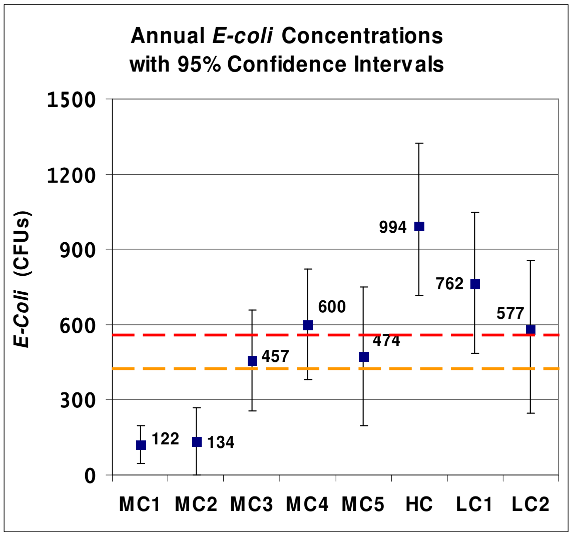

Figure 11. Observed bacteria levels for all locations. The red dashed line represents the state criterion for secondary contact recreation. The orange dashed line represents the state criterion for primary contact recreation (i.e. fishing, swimming, etc).

BMPs that limit cattle accesses to streams (i.e. fencing and off-site watering) should be considered if bacteria levels are to be reduced. Additionally, any state or local programs that target septic system maintenance and upgrades should be identified.

Conclusions

Water quality monitoring in the Marsh Creek drainage has pointed to a few potential areas of opportunity for implementing conservational practices. Carolyn Firth (ISCC) and Clyde Lay (IDEQ) have suggested writing a 319 grant proposal for doing some work along Marsh Creek between Albion and the Six S Reservoir. I would recommend that an intensive riparian survey be conducted on Marsh Creek between MC-3 and Albion sometime this spring to gain a better idea of the exact measures that could be implemented and the potential costs associated with such measures.

BMPs that discourage cattle access to Marsh Creek and Land Creek in the middle and upper portions of the watershed could improve riparian health thereby reducing sediment, TP, bacteria, and water temperatures. This will have the added benefit of improving fish rearing habitat quality. These BMPs might include fencing, off-site watering, and changes in cattle rotation.

Nitrate issues in the lower portion of Marsh Creek are currently being address through the Cassia County Ground Water council.

Cited Works

Campbell, K. Upper Middle Snake River Return Drain Water Quality Monitoring Program, Minidoka and Burley Irrigation Districts, Minidoka and Cassia County, April 1996 – April 1997, 1999.

IDEQ. 2008 Nitrate Priority Area Delineation and Ranking Process.

Idaho Department of Environmental Quality. Water Body Assessment Guidance-Second Edition, 2002.